



BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF SPORTS SCIENCE

**Using Motion Analysis to Enhance the Performance of Elite Sprinters in
Harare**

A dissertation submitted in fulfilment of the requirements for the
Bachelor of Science Honours Degree in Sports Science and
Management

By

Kamungeremu Dicksson

B210381B

July 2024

APPROVAL FORM

The undersigned certify that they have read and recommended to the Faculty of Science and Engineering, Bindura University of Science Education , for acceptance a dissertation entitled, **"Using motion analysis to enhance the performance of elite sprinters in Harare"**, submitted by Kamungeremu Dicksson [B210381B], in partial fulfilment of the requirements for the Bachelor of Science Honours in Sports Science and Management Degree.

Name of Supervisor: Mr.P.Sizara **Signature:**  **Date:** 17/10/2024

Name of Chairperson: Dr.L.T.Charumbira **Signature:**  **Date:** 17/10/2024

DECLARATION

I, Kamungeremu Dicksson, declare that this HBScSSM study is my own effort and is a true reflection of research executed by me. This research in full or part thereof has not been submitted for examination for any degree at any other university/institution.

No part of this dissertation may be reproduced, stored in any retrieval system, or transmitted in any form, or by any means (e.g. electronic, mechanical, photocopying, recording or otherwise) without the prior express permission of me the author, or Bindura University Of Science Education on my behalf.

I, Kamungeremu Dicksson, grant Bindura University of Science Education permission to reproduce this dissertation in whole or in part, in any manner or format, which Bindura University of Science Education may deem fit.

Kamungeremu Dickson

Name of Student

Signature



Date: 10/07/24

DEDICATION

I dedicate this study to my wife Lovejoy, my sons Wayne and Wilmer. May the Almighty God continue to bless you.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my supervisor Mr P. Sizara, without whose expert insight, guidance, patience and support I would not have achieved this. I would like to thank my wife and my sons for supporting me throughout the project.

My appreciation also extends to my classmates whose meaningful discussions influenced my work. Likewise, I am grateful to the Management and Administration of Bindura University of Science Education for granting me the opportunity to carry out my study and availing the resources required. The coaches and athletes in Harare, could not go unmentioned without their cooperation the project was not going to be a success.

Above all, I am eternally grateful to my Lord and Saviour for the gift of life and for granting me the grace to accomplish my study

ABSTRACT

This study assessed motion analysis to enhance the performance of elite sprinters in Harare. The research adopted a mixed method research design. From a population of 70 elite sprinters and coaches, proportional stratified and random sampling method were employed to draw 56 questionnaire respondents for the study. Interviews were conducted on 7 coaches. Questionnaires were personally administered to the respondents at their workplaces. Interviews were also personally conducted by the researcher. Quantitative data were analysed with the help of the Statistical Package for Social Sciences (SPSS) version 21 whilst qualitative data was thematically analysed using NVivo. The study established that some motion analysis procedures were being utilized to enhance performance of elite sprinters in Harare as evidenced by average ($M = 4.64$ and $\pm SD = .749$). It was however further found that motion analysis procedures are not being fully utilized in the training of elite sprinter to enhance performance given that some respondents were not aware of their use as shown by ($M = 1.48$ $\pm SD = .809$). The study concluded that motion analysis contribute to greater performance of elite sprinters. It is recommended that motion analysis procedures be fully utilized in elite sprinter training to enhance their performance. After considering the limitations of study, areas for possible future research were also suggested.

KEY WORDS: Motion Analysis, Elite sprinters

Table of Contents

APPROVAL FORM.....	i
DECLARATION	i
DEDICATION.....	iii
ACKNOWLEDGEMENT	iv
ABSTRACT.....	v
CHAPTER ONE.....	1
THE PROBLEM AND ITS SETTING.....	1
1.1 INTRODUCTION	1
1.2 BACKGROUND OF THE STUDY	1
1.3 STATEMENT OF THE PROBLEM	3
1.5 RESEARCH QUESTIONS	4
1.5.2 Secondary questions.....	4
1.6 RESEARCH OBJECTIVES	4
1.6.1 Primary objective	4
1.6.2 Secondary objectives	4
1.7 DELIMITATION OF THE STUDY	5
1.7.1 Geographical delimitation.....	5
1.7.2 Time delimitation.....	5
1.8 STUDY OUTLINE.....	5
1.9 CHAPTER SUMMARY.....	6
CHAPTER TWO	7
LITERATURE REVIEW	7
2.1 INTRODUCTION	7
2.2 CONCEPTUALISATION	7
2.2.1 Key components of motion analysis	7

2.2.1.1 High-Speed Cameras	7
2.2.1.2 Motion Capture Systems	8
2.2.1.3 Force Plates	9
2.2.1.4 Electromyography (EMG)	9
2.2.1.5 Video Analysis Software	9
2.2.1.5 Biomechanical Parameters	10
2.3 THEORETICAL REVIEW	11
2.3.1 Newton's Theory	11
2.3.1.1 Newton's first law	11
2.3.1.2 Newton's Second Law acceleration	12
2.3.1.3 Newtons Law 3	13
2.3.2 A biomechanical model	15
2.4 EMPIRICAL EVIDENCE	16
RESEARCH GAP	18
2.6 CHAPTER SUMMARY	18
CHAPTER THREE	20
RESEARCH METHODOLOGY	20
3.1 INTRODUCTION	20
3.2 RESEARCH APPROACH	20
3.3 TIME HORIZON	20
3.4 RESEARCH DESIGN	20
3.5 POPULATION AND SAMPLING	21
3.5.1 Population	21
3.5.2 Sampling	21
3.5.2.1 Sampling techniques	21

3.5.2.2 Stratified random sampling	21
3.5.2.3 Purposive sampling	21
3.5.3 Sample Size Determination.....	22
3.5.3.1 Quantitative study	22
Table 3.1: Proportional stratified sampling by category for quantitative data.....	23
Source: Own compilation	23
3.5.3.2 Qualitative study	23
3.6 DATA COLLECTION PROCEDURES	23
3.6.1 Pilot Study.....	23
3.6.2 Main Study.....	23
3.6.2 .1 Questionnaire	23
3.6.2.2 Interview guide	24
3.7 DATA ANALYSIS AND PRESENTATION	24
3.7.1 Quantitative.....	24
3.7.2 Qualitative.....	24
3. 8 VALIDITY AND RELIABILITY	25
3. 8.1 Validity	25
3.8.1.2 Reliability.....	25
3.9 ETHICAL CONSIDERATION	25
3.9.1 Informed consent	25
3.9.2 Right to privacy.....	25
3.10 CHAPTER SUMMARY.....	26
CHAPTER FOUR.....	27
RESULTS AND DISCUSSION.....	27
4.1 INTRODUCTION	27

4.2 RESPONSE RATE	27
4.2.1 QUANTITATIVE DATA.....	27
RELIABILITY OF THE RESEARCH INSTRUMENT	28
4.3 DEMOGRAPHIC DATA	29
4.4 PRESENTATION AND ANALYSIS OF DATA LINKED TO THE RESEARCH OBJECTIVES	29
4.4.1 QUANTITATIVE.....	29
4.5.1 Motion analysis currently being used to enhance the performance of elite sprinters in Harare.....	29
4.5.3 Motion analysis procedures that can be adopted to enhance the performance of elite sprinters in Harare.....	34
4.4.2 QUALITATIVE ANALYSIS	35
4.5 CHAPTER SUMMARY.....	38
CHAPTER FIVE	39
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.....	39
5.2 SUMMARY OF MAJOR FINDINGS.....	39
5.3 CONCLUSIONS.....	40
5.4 LIMITATION OF THE STUDY	41
5. 5MPLICATIONS/RECOMMENDATIONS	41
5.5.1 Implications for practice	41
REFERENCES	43
Appendix A: Questionnaire for Elite coaches and sprinters	47
Appendix B: Interview guide used to guide discussions with coaches	51

List of tables

Table 3.1: Proportional stratified sampling by category for quantitative data..	22
Table 4.1: Response rate for questionnaires	26
Table 4.2: Cronbach's Alpha	27
Table 4.3: Age of respondents	28
Table 4.4: Gender of respondents	29
Table 4.5: Education level of respondents	30
Table 4.6: Demographic data for interview participants	33
Table 4.7: Motion analysis currently being used to enhance the performance of elite sprinters in Harare	34
Table 4.8: Effectiveness of the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare	36
Table 4.9: Motion analysis procedures that can be adopted to enhance the performance of elite sprinters in Harare	38

List of figures

Figure 2.1: Camera layout for the men's 60 m World Indoor Championships 2018 indicated by green-filled circle	8
Figure 2.2: A sprinter at a constant speed	12
Figure 2.3: A sprinter decelerating	13
Figure 2.4: The reaction of force	14
Figure 4.1: Gender of respondents	29
Figure 4.2 Education level of respondents	31
Figure 4.3: Training age as a sprinter/coach	32
Figure 4.4: Effectiveness of the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare	37

List of abbreviations

EMG	Electromyography
GPS	Global Positioning System
NAAZ	National Athletics Association of Zimbabwe
NSAZ	National Sports Association of Zimbabwe
SPSS	Statistical Package for Social Sciences

List of Appendices

Appendix A: Questionnaire for Elite coaches and sprinters.....52

Appendix B: Interview guide used to guide discussions with coaches of elite sprinters in Harare.....56

CHAPTER ONE

THE PROBLEM AND ITS SETTING

1.1 INTRODUCTION

The development of an elite sprinter requires much more than knowledge of technique. Any coach would point out that teaching an athlete how to compete involves understanding a wide range of subjects, including biomechanics, nutrition, psychology, and biochemistry. In an attempt to put together a development plan, a coach needs to make use of all the information at their disposal. Coaches search through such data for a variety of signs that often indicate the recalibre of an athlete's performance. Chapter One highlights the background of the study, the statement of the problem, the aim and objectives of the study, the research questions and the significance of the study. It further provides delimitation of the study, assumptions, and limitations and ends with a summary.

1.2 BACKGROUND OF THE STUDY

Elite sprinting is a popular sport all around the world. Stoll (2023) pointed out that approximately 2.05 billion audience watch the televised 2020 Olympic games in Tokyo which actually took place in 2021. SafeAbroad Forecast Report (2024) forecasted that the 2024 Summer Olympics to be held in Paris will have 3 billion viewers whilst Olympic Marketing Fact File (2024) forecasted the viewers figure at 3.7 billion in 220 countries. The 100-meter race is one of the Olympic Games "blue-ribbon" events, according to Sandamas (2021), and the holder of the world record is frequently referred to in the media as the "fastest man on Earth." The 100m dash is arguably the most prestigious event in track-and-field (Wouwe, Hicks, Delp & Liu, 2023). Despite being a straightforward sport, the 100-meter sprint demands competitors to run at their fastest possible speed, and the winner takes home the biggest awards in track and field (Michiyoshi, 2017).

Athletes' performance in sprint events is mostly determined by their capacity to accelerate their mass and generate a high running velocity in the forward direction, according to Haugen, Breitschadel, and Seiler (2019). Sports scientists employ motion analysis, a useful tool, to examine and evaluate athletes' movement patterns, particularly those of elite sprinters. In established nations like Europe and Latin America, motion analysis stretches back to the early 1800s. American

sprinter Thomas Burke won his race in 1920, the inaugural modern Olympic Games, in 12 seconds (Fasih and Zia, 2020). This followed a shift from the customary methods, in which every athlete had his distinct way of starting and running, to a scenario in which runners used the starting blocks to share a common running style for the first time.

Comparisons of the performance of such athletes as Usain Bolt - 9.58 seconds (Jamaica), Yoshihide Kiryu- 9.98 seconds (Japan), Lalu Muhammed Zohri-10.18 seconds (Indonesia) and Cray Eric Shuwan- 10.25 seconds (Philippines) was made possible through motion analysis. The above-mentioned athletes were chosen for their varying representation in nation, age and coaching methods. Comparison between their sprinting performance was carried out based on step frequency and step length all being measured through motion analysis.

The tendencies of the coaching staff to value scientific information on physical characteristics are understandable, as their effect on performance is advocated by various researchers (Berg, 2015). Cunniffe et al. (2009) and Coughlan et al. (2011) consider time motion analysis to be the best method for determining the physical demands of athletes via movement activities. Motion analysis is used when the duration, type and frequency of the different movement patterns within a sport are analysed. New technology such as the 10Hz global positioning system (GPS) has made it possible to conduct valid and objective motion analyses of movement activities which were once a challenge (Johnston, Watsford, Pine, & Sporri, 2013). With motion analysis tools like force plates, motion capture systems, and high-speed cameras, precise information on several elements of sprinting performance, such as stride length, stride frequency, ground contact time, and joint angles, may be obtained.

In competitive sports, to achieve good results, athletes cannot only rely on sports talent but also rely on scientific training methods. Athletes are also required to have relevant sports knowledge to shine in the arena. Therefore, athletes, coaches and physical education teachers should pay attention to the physics knowledge involved in physical education. Among the physical knowledge, motion analysis is the basis for mastering sports skills, changing technical movements, creating scientific training methods and improving sports performance (Li, Zhou, Tao & Du, 2023).

Some Zimbabwean local schools and academies such as St Johns, Bindura Academy, Prince Edward, Gold Academy, Elite Sprints Academy, and Sports Science Lab (SSL) among others have

since realised the merits of using motion analysis. However, Banda (2015) alluded that research on motion analysis in Zimbabwe is lacking when compared with international counterparts, even though scientific-based research can equip strength and conditioning coaches in sports with the precise knowledge to aid the development of individualised conditioning programmes for the athletes.

This review, aims to increase the awareness of various motion analysis procedures available and identify practical implications of the established body of knowledge, while highlighting areas that require further exploration.

1.3 STATEMENT OF THE PROBLEM

Qualifying for high-level competitions such as the World Championship and or Olympics has remained a challenge for Zimbabwean locally-based sprinters which have seen none of these athletes hitting the qualifying time of 10.00 seconds since 2007. Whilst the locally based sprinters have failed to qualify, some Zimbabwean athletes who are based in the developed world such as America have been qualifying for the prestigious events. The likes of Brian Dzingai (2009 Olympics- 200 metres:20.40 seconds; Ngonidzashé Makusha-100 metres:9.89 seconds); (Tapiwa Makarawu 2023 World Champions -200 metres: 20.20 seconds; 2024 Paris Olympics -200 metres : 19.93 seconds, Makanakaishe Charamba also qualified for 2024 Olympics 200 metres with 20.00 seconds). The performance differences point to differences in athletes' development programmes which could be linked to motion analysis as pointed out by (Mero, Komi and Gregor, R.) that understanding biomechanical factors in sprint running is very useful because of their critical value to performance considering that sprinting is more technical and requires close analysis. Whilst motion analysis has long been adopted in some countries, no studies have been found on the use of motion analysis to enhance the performance of elite sprinters in Zimbabwe, hence this study.

1.4 Significance of the study

Considering the biomechanical factors such as block start have been found to aid performance, the study findings, if practically implemented by coaches and sprinters, will help improve performance of elite sprinters in Zimbabwe. The study results shall be made available online as well as distributed to various elite sprinters clubs throughout the country. The researcher also as a

sprinter athlete and coach will apply the motion analysis procedures to his training and the training of other athletes under his guidance.

1.5 RESEARCH QUESTIONS

1.5.1 Primary Question

How can motion analysis be used to improve the performance of elite sprinters in Harare?

1.5.2 Secondary questions

- What motion analysis procedures are currently being used to enhance the performance of elite sprinters in Harare?
- How effective are the motion analysis methods currently being used to enhance the performance of elite sprinters in Zimbabwe?
- What motion analysis methods can be adopted to enhance the performance of elite sprinters in Harare?

1.6 RESEARCH OBJECTIVES

1.6.1 Primary objective

To establish how motion analysis can be used to improve the performance of elite sprinters in Zimbabwe.

1.6.2 Secondary objectives

- To identify the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare.
- To evaluate the effectiveness of the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare.
- To identify the motion analysis procedures that can be adopted to enhance the performance of elite sprinters in Harare.

1.7 DELIMITATION OF THE STUDY

1.7.1 Geographical delimitation

The study was focused on Harare based elite sprinters.

1.7.2 Time delimitation

The data used is delimited to the period between 2005 to 2024.

1.8 STUDY OUTLINE

The dissertation comprises of five chapters excluding the list of references and appendices which are organised as follows:

Chapter One: The problem and its setting

Chapter one provides the nature and scope of the study. It sets out the tone of the study highlighting background of the research, research problem, research questions and objectives. The chapter also draw attention to significance of the study.

Chapter Two: Literature Review

The chapter present literature basing og the conceptual framework, theoretical framework, empirical framework and a conceptual model.

Chapter Three: Materials and Methods

Chapter three presents a discussson of the research methodology and methods which were employed in the study.

Chapter Four: Data analysis and Presentation

The chapter presents data analysis and presentation of results through the use of charts, tables and graphs. Quantitative data is analysed using SPSS whilst qualitative data is analysed using thematic analysis.

Chapter Five: Summary, Conclusions and Recommendations

This chapter provides the summary of study findings, conclusions and recommendations .

1.9 CHAPTER SUMMARY

Chapter one provided an insight into the significance of this research by presenting the background to the study, statement of the problems, aim and secondary objectives, research questions, significance and delimitation, assumptions and limitations of the study. The next chapter concentrated on a review of the literature which supports the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents review of the literature in line with the study objectives. The conceptual framework, theoretical framework, empirical framework and finally the conceptual model are presented. Therefore this literature review intended to identify knowledge gaps within the available literature on motion analysis and its use to enhance elite sprinter performance in Zimbabwe. Review of literature hence served in developing a healthy starting point for motion analysis understanding and, bringing to light new areas for research and knowledge conception (Collis and Hussey, 2013).

2.2 CONCEPTUALISATION

2.1.1 Key components of motion analysis

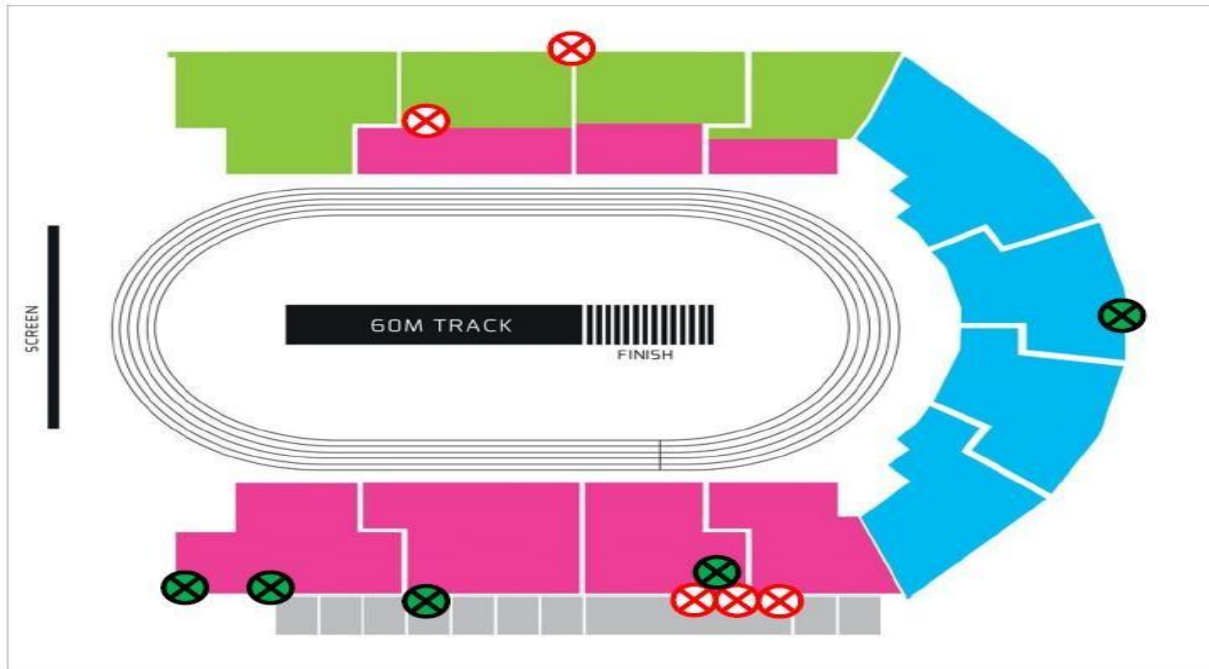
Motion analysis of sprinters typically involves the following components:

2.2.1.1 High-Speed Cameras

In order to have a thorough understanding of sprinters' movements and technique, high-speed cameras are utilized to record their actions at a speedy frame rate (Busca, Quintana, and Padulles, 2016). According to Chidambaram and Lumintuarso (2018), track and field activities like throwing, running, and jumping are quantifiable individual sports that lend themselves to precise analysis through the use of video technology. Additionally, numerous camera angles can be employed to record multiple aspects of the sprinter's movement. Athletes in motion within the calibrated volume around block exit and the sprint start were captured by four Sony PXWFS7 cameras operating at 150 Hz (shutter speed: 1/1250; ISO: 20004000; FHD: 1920x1080 px), according to Walker et al (2019). Some high speed cameras permit users to measure time, power, acceleration and mechanical effectiveness of line sprints (Busca et al, 2016)High speed cameras can present images that a coach can not see with naked eyes such as high

shutter speeds, stop motion, and high frame rates which captures pivotal frames such as moment of take-off (Busca et al, 2016).

Figure 2.1: *Camera layout for the men's 60 m World Indoor Championships 2018 indicated by green-filled circles*



Source: Biomechanical Report for the IAAF World Indoor Championships 2018

2.2.1.2 Motion Capture Systems

This system tracks the sprinter's movement in three dimensions by using markers positioned on important anatomical landmarks. Precise information on joint angles, segmental motion, and overall body kinematics during sprinting can be obtained with this kind of technology. The procedure yields data that can be used to provide both qualitative and quantitative feedback regarding the activities, performance, and physical demands placed on the athlete (Banda, 2015).

2.2.1.3 Force Plates

Force plates are used to measure ground reaction forces generated by the sprinter during each foot strike. This data then helps coaches understand how sprinters interact with the ground, the sprinter's propulsion mechanics, and the distribution of forces throughout the sprinting cycle (Smith & Ditroilo, 2023). Force plates are frequently used in biomechanics labs to quantify ground forces involved in human motion. They are recognized as an outstanding teaching tool for demonstrating the kinematics and dynamics of motion (Wardoyo, Hutajulu and Togibasa, 2016). They offer details on the outside factors influencing movement, which can help a sports scientist or coach assess an athlete's skill development in a quantifiable manner. According to Hicks (2023), software analyzes force plate data, identifies important performance measures, and presents the findings graphically.

2.2.1.4 Electromyography (EMG)

Sensors called electromyography (EMG) can be used to gauge how electrically active muscles are during sprinting. This information provides insights into muscle activation patterns, coordination, and timing, which are very important for understanding the neuromuscular aspects of sprinting performance. Electromyography (EMG) is a widely acknowledged helpful technique for improving our understanding of performance determinants and potential injury concerns in sprinting (Howard, Conway, & Harrison, 2016). For athletes and their coaches, sports performance monitoring is crucial to injury prevention because increasing speed and muscle exhaustion can raise the risk of injury.

2.2.1.5 Video Analysis Software

With video analysis software, data from motion capture systems and high-speed cameras is processed and examined. A lot of software programs harvest data from video files using techniques like infrared motion capture, which makes the process more effective and offers strong data support for conventional empirical training. With the use of this software, coaches may keep an eye on certain movement patterns, calculate crucial metrics like stride length and frequency, and assess the sprinter's technique visually (Post, Koncan, Kendal & Cournoyer, 2018). Coaches can more

precisely spot disparities and direct students toward correction and optimization by gathering and evaluating athletes' data (Qui, Guan & Liu, 2023).

2.2.1.5 Biomechanical Parameters

Motion analysis of sprinters typically includes the measurement and analysis of various biomechanical parameters, such as stride length, stride frequency, ground contact time, joint angles, joint moments, and segmental velocities. Chidambaram and Lumintuarso (2018) pointed out that the key to sprinting velocity is determined by two main components namely step length and step frequency. Athletes' stride characteristics consequently become crucial to obtaining a successful performance. These variables can enhance performance and offer insightful information about the mechanics of sprinting.

Haugen et al (2019) posted that by integrating these components, researchers, coaches, and sports scientists can conduct comprehensive motion analysis of sprinters to evaluate their technique, performance, and potential areas for improvement. Janowski, Zielinski, Wlodarczyk and Kusy (2017) pointed out that, in sprinting, one particular principle does seem to stand out – a constant need to uphold the symmetry of motion. Recent findings of Trivers et al (2014) suggest that elite athletes have a very high association between the right and the left knee and the ankle symmetry and their sprinting performance. Findings presented by Pappas, Paradisis and Vagenas (2015) imply that even young athletes display rather small individual asymmetries in the lower limb biomechanical parameters, such as flight time, acceleration or velocity. Korhonen et al (2010) indicate that professional athletes, regardless of age, provide repeatable and symmetric values of their strides especially during the acceleration phase and further on.

There is consensus between Haugen et al (2019); Trivers et al (2014) and Vagenas (2015) that very high association between the right and the left knee and the ankle symmetry and their sprinting performance, the same view also taken by the researcher.

2.3 THEORETICAL REVIEW

There are several theories and models used in motion analysis to understand human movement. The study adopted two theories to analyse the use of motion analysis on elite sprinter performance, which are Newton's Theory and the Biomechanical Model. According to Glazier, Davids, and Bartlett (2014) and Smith (2007), these theories were considered as the primary theories guiding motion analysis.

2.3.1 Newton's Theory

In 1687 Newton propounded the concept of mass and force, where he created three laws of motion to describe the relationship between a body and the forces acting upon it, and how the body moves in response to those forces normally called the *Philosophiae Naturalis Principia Mathematica*. Newton's laws of motion are fundamental principles in biomechanics and motion analysis. These laws describe how forces influence the motion of objects and are commonly applied to analyze the movement of athletes (Machado & Carvalho, 2020). According to Newton, a force is an interaction between two bodies or between a body and its environment. Newton's Laws express three states which are; a body remains at rest or in uniform motion unless acted upon by a net force; a body acted upon by a net force moves in such a manner that the time rate of change of the momentum equals the force; and if two bodies exert forces on each other, these forces are equal in magnitude and opposite in direction.

2.3.1.1 Newton's first law

Newton's first law Newton's first law of motion describes what happens when zero net force acts, which means that all forces acting must cancel out. Until there is a net force acting upon a body, it remains at rest or in uniform motion. In Figure 2.2 the forces shown by green arrows cancel out. The vertical forces are the same size, that is, arrows are the same length, but in opposite directions. All forces cancel out since the horizontal forces are likewise equal in magnitude and directed in the opposite directions. An object is either motionless or travels at a constant speed when there is no net force acting on it. Hence when any object moves at constant velocity, all forces must cancel out, and the net force must be zero. The law of inertia is another name for Newton's first law. According to the theory of inertia, a heavy item will remain at rest unless a force is applied to move

it, and once it is moving, a force will be needed to modify its motion—that is, to accelerate or decelerate it. Li et al (2023) alluded that according to Newton's first law if athletes suddenly accelerate or decelerate in the process of running at a constant speed, the athletes will become more tired because changing the original speed will consume more physical energy while maintaining a uniform speed will save more effort.

Figure 2.2: *A sprinter at a constant speed*



Source: Biomechanical Report for the IAAF World Indoor Championships 2018

2.3.1.2 Newton's Second Law acceleration

Newton's second law of motion describes what happens when a net force acts on a body. When a net force acts on a body, the movement of the body is such that the force and the time rate of change in momentum are equal. The body can accelerate or decelerate, or its direction can be altered, by a net force. A sprinter accelerates because of the net force exerted, which must be forward in order for the sprinter to accelerate ahead. There is a net push rearward as the sprinter decelerates. In Figure 2.3, the vertical arrows representing vertical forces are the same length but in opposite directions, and hence cancel out. There is a net force acting backwards as a result of the two horizontal forces operating in reverse. This means that she is decelerating horizontally. According to Newton's second law, an object will accelerate more quickly the larger the net force. Therefore, a stronger sprinter ought to be able to get off the blocks more quickly. However, the more mass an object has, the less the acceleration for a given force. Thus, the acceleration of a heavier, more substantial sprinter will be less than that of a lighter sprinter. This is expressed mathematically as $F = m \times a$ (force = mass \times acceleration).

Figure 2.3: A sprinter decelerating



Source: Biomechanical Report for the IAAF World Indoor Championships 2018

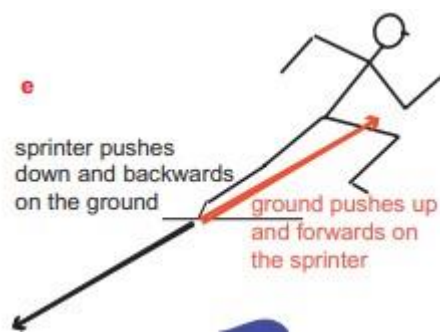
In the track and field 100 m dash competition, athletes need to use an auxiliary equipment called starter, because 100 m dash is a speed sport. In this sport, athletes should overcome the factors of gravity and quality, maintain acceleration throughout the whole process, and rush across the finish line at the fastest speed to achieve success in the competition (Li et al, 2023). The starter's function is to enhance the athletes' initial acceleration, which is applied to the resultant force of Newton's second law, by providing a stronger resultant force through the starter's back pedal at the beginning. The athlete receives the force from the ground after pushing it and creates a fresh consequent force. The acceleration increases with the resultant force. Li et al (2023) summed up by pointing out that, in Newton's second law, the resultant force is the net force, which can also be called the sum of all forces, that is, the final result obtained by adding the size and direction of all forces. The acceleration of an object is directly proportional to the resultant force and inversely proportional to the mass of the object, that is the same acceleration will change the resultant force on different masses

2.3.1.3 Newtons Law 3

Newton's third law of motion describes what happens when two bodies or objects exert forces on one another. Equal and opposite in nature, action and reaction are always seen in pairs. One body is affected by an action, and the other body is affected by the response to this action. When two bodies press on one another, the forces are directed in the opposite direction and have the same magnitude. At a sprint start, the athlete pushes back on the blocks as hard as possible, figure 2.4,

and the blocks push forward on the athlete, this push forward is the reaction force. The athlete accelerates forward as a result of the reaction. In Figure 2.4, a sprinter pushes backwards on the ground with feet (this is the force in black, the action). At the same time, the ground pushes the sprinter forward (this is the force in red, the reaction force).

Figure 2.4: The reaction of force



Source: Biomechanical Report for the IAAF World Indoor Championships 2018

When an athlete steps on the starter pedal to begin a 100-meter dash, that force is applied to the pedal; the force the pedal imparts to the athlete is known as the response force. In sports competitions and training, athletes can also improve their performance through sports mechanics and Newton's third law. In the starting link of track and field 100m Sprint, athletes should use the starter to run up. Athletes should run up using the starter in the track and field 100-meter sprint starting link. Faster acceleration is possible with the starting link, and Newton's law is also used to determine the ideal angle for the front and back pedals of the starter. The front pedal is generally 40–45°, and the rear pedal is generally 70–80°. At this angle, the starting pedal can apply its greatest force and receive its maximum response force. If the angle is too low, it will not have the effect. If the angle is too high, it is easy to cause sports injury due to an unstable centre of gravity (Li et al, 2023)

2.3.2 A biomechanical model

Numerous biomechanical models of sprinting have been proposed, and each model advances our knowledge of the biomechanics and execution of the sport. A biomechanical model is a theoretical framework that integrates principles of mechanics and anatomy to analyze and understand human movement (Tai, Zhang & Zhao, 2023). The history of biolocomotion, later to become biomechanics can be traced back to approximately the second half of the seventeenth century (Clarys and Alewaeters, 2003). The major contributor to this emergent science was Swammerdam in 1658. Motion analysis using cinephotography was then employed, providing the foundation for biomechanics. In the context of motion analysis, a biomechanical model serves as a foundation for studying the forces, torques, and kinematics involved in various activities, such as sprinting. According to (Bezodis, Trewartha, and Salo, 2008) biomechanical model in motion analysis encompasses such key components as segmentation, joint kinematics, muscle mechanics, ground reaction forces, centre of mass dynamics and energy expenditure.

Segmentation divides the body into segments such as the head, trunk, upper limbs, and lower limbs to analyze the movement of each segment independently and in relation to the whole body (Chen, Hsieh, Hsu & Huang, 2006). Segmental analysis allows researchers to understand how different parts of the body contribute to overall motion. Joint kinematics refers to the study of joint angles, velocities, and accelerations during movement. By analyzing joint kinematics, coaches can assess the range of motion, coordination, and timing of joint movements in sprinting (Bezodis, Trewartha, and Salo, 2008). Understanding muscle mechanics involves analyzing the forces generated by muscles, muscle activation patterns, and muscle-tendon interactions during movement. Muscle mechanics play a critical role in generating propulsion, absorbing impact forces, and stabilizing joints during sprinting (Howard, Conway & Harrison, 2016).

Ground reaction forces are the forces exerted by the ground on the body during locomotion. As alluded to by (Hunter, Marshall & McNair, 2005), analyzing ground reaction forces provides insights into how sprinters interact with the ground, generate propulsion, and control their movements. The centre of mass is a point that represents the average location of the body's mass. Analyzing the dynamics of the centre of mass helps researchers understand how sprinters control their balance, stability, and momentum during acceleration and deceleration (Hewitt, Cronin,

Button & Hume, 2011). Biomechanical models can also include energy expenditure analysis to assess the metabolic cost of movement. Understanding the energy demands of sprinting can help optimize performance and training strategies for elite athletes.

By incorporating these components into a biomechanical model of motion analysis, researchers can gain a comprehensive understanding of the mechanical and physiological factors influencing human movement in activities like sprinting (Lu & Cheng, 2012). This integrated approach allows for a detailed analysis of biomechanical variables and their impact on performance, injury prevention, and technique optimization.

Various scholars such as (Bezodis, Trewartha, and Salo, 2008); (Chen, Hsieh, Hsu & Huang, 2006) concur on the fact that the body is divided into segments to analyze the movement of each segment independently and in relation to the whole body.unter et al (2005) and Hewit et al (2011) expressed the same view that ground reaction forces are the forces exerted by the ground on the body during locomotion. The researcher shares similar view regarding segmentation of the body as well as the ground reaction forces to the body

2.4 EMPIRICAL EVIDENCE

A study by Chidambaram and Lumintuarso (2018) which aimed to determine the frequency of steps of 100 meters sprint utilized the method of analyzing a video with dartfish. The tests were conducted by examining athletes who are; Usain Bolt - 9.58 seconds (Jamaica), Yoshihide Kiryu— 9.98 seconds (Japan), Lalu Muhammed Zohri- 10.18 seconds (Indonesia) and Cray Eric Shuwan— 10.25 seconds (Philippines). The athletes were chosen to compare their sprinting performance based on step frequency and step lengths. In the study, Chidambaram and Lumintuarso (2018) assert that the performance of sprinters is enhanced through better training that is achieved by breaking down recorded images through biomechanics analysis. They discovered that the 100-meter sprint running speed is significantly influenced by the anthropometry profile. By assessing the two main factors determining the speed of 100 meters through the use of motion analysis, the study concluded that the two factors have a very decisive role. Usain Bolt, who has a normal step frequency, was able to respond to the deficiency by having a very high step length as until now he still holds the 100m runaway record, even though he resigned in 2017 after the World Athletics

Championship in London. On the other hand, Zohri was found to have opportunities to improve by means of simply increasing step length without reducing the step frequency. The study findings highlight the importance of motion analysis on elite sprinter performance.

Another study by Janowski, Zielinski, Wlodarczyk, and Kusy (2017) sought to identify variances and/or similarities in technique while assessing individual kinematic features in highly trained sprinters throughout the "set" position, block clearance, and a 20-meter acceleration phase. The Polish national team's two sprinters were the subjects of the measurements. The MyoMotion system (Noraxon Inc., USA) was utilized as a wireless portable device. All limbs, the trunk, and the head were measured for angular shifts and accelerations. Results indicated that increased motion asymmetry between sides brought about stride fluctuation and worsened sprint performance. This effect occurred when the sum of the discrepancies for hip, knee and ankle joints exceeded 20° or if one joint exceeded 10°. For acceleration, the adverse effect occurred when the range exceeded 1.40 G during the acceleration phase. Greater asymmetry resulted in lower acceleration during block clearance. Despite best efforts, the rear hip and right knee angles during block clearing did not surpass 110° and 100°, respectively. Performance does not appear to be significantly impacted by the "set" position. The conclusion reached was that sprinters have unique kinematic traits.

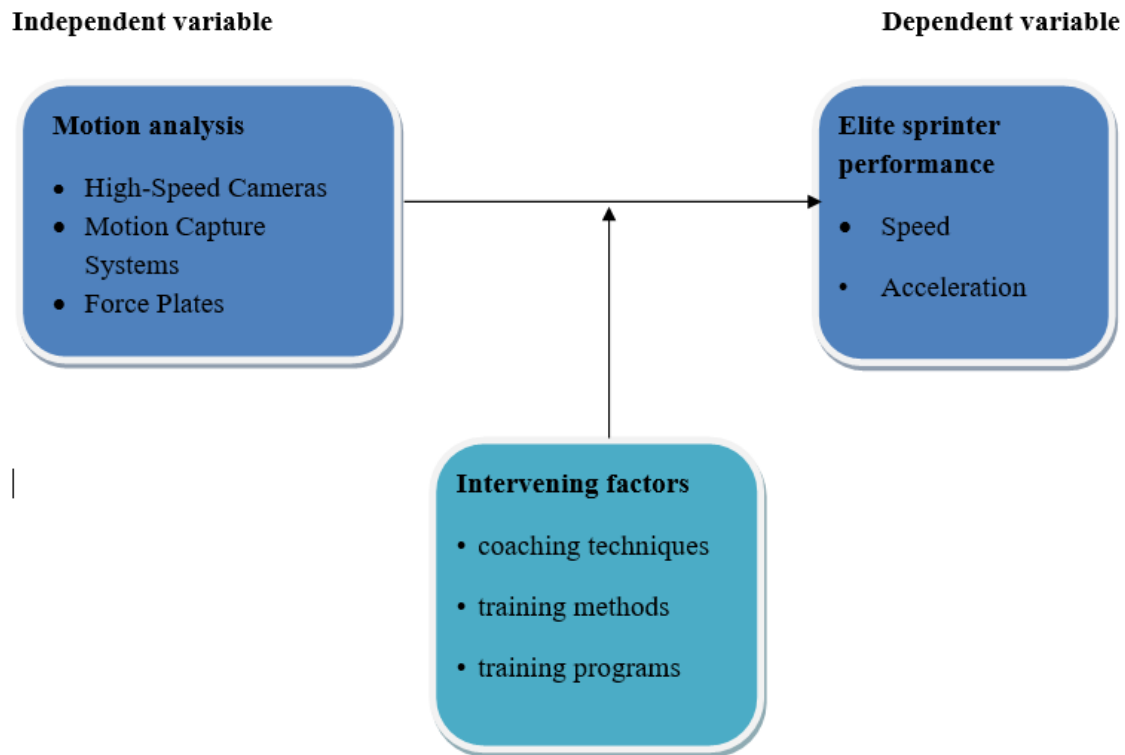
Fast block clearance and stride symmetry are key factors affecting sprint performance during the 20-metre acceleration phase.

A study by Neil, Bezodis, Grant, and Aki (2008) aimed to investigate how leg kinematics contribute to the performance, in terms of external horizontal power production, of three elite sprinters during the block and first step phases of a sprint. Sprinter B produced the most block phase power and had the largest hip extension, especially at the back leg. Although Sprinter A's horizontal block exit velocity was higher, it seemed that this was more the result of a prolonged push than of increased average force production.

Sprinter B again delivered the maximum horizontal power during the initial stance, demonstrating the largest overall stance leg joint extension. The leg extensions of the other two sprinters were comparable to one another. Sprinter A's center of mass may have been further in front of his foot at touchdown, allowing him to produce more horizontal force. These findings reinforce previous

suggestions that biomechanists and coaches should not quantify performance based on velocity alone. Power is a more suitable measure, and can be calculated from accurate kinematic data. During the first stance, a large extension of the leg joints appears to benefit performance. The positioning of the CM further in front of the stance foot at touchdown could also improve performance by directing the subsequent leg extension more horizontally.

2.5 CONCEPTUAL MODEL



RESEARCH GAP

A research gap is a subject or issue that is yet to be addressed by previous studies (Elyse Wolf, 2019). Whilst there was literature found on the use of motion analysis to enhance performance of sprinters in the developed countries, no such such studies were found on this area in the set up of undeveloped countries such as Zimbabwe. This gap hence rendered this study necessary.

2.6 CHAPTER SUMMARY

This chapter discussed the literature review based on the following research objectives;

To establish the motion analysis currently being used to enhance the performance of elite sprinters in Zimbabwe; to evaluate the effectiveness of motion analysis that is currently being used to enhance the performance of elite sprinters in Zimbabwe; and to identify motion analysis methods that can be adopted to enhance the performance of elite sprinters in Zimbabwe. Chapter three highlighted the research methodology that the study used.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The previous chapter provided the related literature guiding the study. This chapter outlines the methodology of the study which is a specific way of conducting research that may incorporate multiple research methods (Giri, 2021). It consists of various steps that are generally adopted by the researcher in studying the research problem. These include research approach, strategy, target population, sampling procedure and sample, data collection procedure, and data analysis. The researcher adopted the following research methodology to investigate the research problem.

3.2 RESEARCH APPROACH

The study adopted a mixed methods approach. The mixed methods approach was chosen because it allow incorporation of both qualitative and quantitative approaches in a single study, thereby giving a whole picture of the problem being examined.

3.3 TIME HORIZON

The study adopted a cross-sectional research. The choice was based on its capability to allow collection of data on a single point in time, its relative cheapness and less time consuming (Zuleika & Siswo, 2022).

3.4 RESEARCH DESIGN

The study used a concurrent mixed method approach. This approach was chosen because it not only permits the integration of qualitative and quantitative methods in a single study but also blends them so that they interact to provide a comprehensive understanding of the issue under investigation (Cresswell, 2014). The study used a survey through questionnaires to collect quantitative data as well as interviews through the use of an interview guide to collect qualitative data. Quantitative data was analysed through the use of SPSS and qualitative data through thematic analysis.

3.5 POPULATION AND SAMPLING

3.5.1 Population

A population is referred to as the set of units from which the sample is drawn (Bryman, 2016). The study population comprised 60 elite sprinters and 10 coaches in Harare, Zimbabwe affiliated with the National Athletics Association of Zimbabwe (NAAZ).

3.5.2 Sampling

3.5.2.1 Sampling techniques

Sampling is the practice of selecting a fraction of the population to approximate its characteristics as a whole (Neuman, 2015). Even though it were feasible to collect data from every segment of the population, such factors as time, money, and human resources would make it impracticable (Sekeran and Bougie, 2013). With that in mind, sampling becomes key to making a gathering of data easier. In the study, probability (stratified and simple random sampling) was used for selecting quantitative data respondents whereas non-probability (purposive sampling) was done for qualitative data participants.

3.5.2.2 Stratified random sampling

In cases where there is a heterogeneous population, stratified sampling is the most excellent method to apply. As the population is composed of sprinters and coaches who are distinct and specific subgroups stratified sampling became suitable. Simple random sampling was then engaged within each subgroup to select study respondents. The researcher chose participants for the sample such that every participant had an equal chance of being selected from the population (Cresswell & Guetterman, 2019). The final study participants were proportionally chosen from the subgroups.

3.5.2.3 Purposive sampling

Purposive sampling also known as judgemental sampling is about choosing cases that the researcher considers appropriate to answer the research questions (Saunders et al, 2016). The

researcher purposively chose coaches for interviews as they were deemed to be rich in sought-after information about motion analysis and elite sprinter performance.

3.5.3 Sample Size Determination

3.5.3.1 Quantitative study

The researcher used Yamane's formula (1967) to determine the sample for the quantitative study. Yamane's formula has proved to be appropriate, reliable, and generally accepted through constant use by many academic researchers over the past years, despite some arguing that it is old. The formula is highly recommended for simple random sampling. Given the population of 70 elite sprinters and coaches in Harare, Zimbabwe, the required sample size was 60 respondents, calculated as illustrated below:

$$n = \frac{N}{(1+N(e)^2)}$$

Where: N=Population size (70); e=Margin of error (0.05); n=Sample (?)

$$n = \frac{70}{(1+70(0.05)^2)}$$

$$n = 60$$

The sample size for the study using Yamane's formula was therefore 60 respondents. To proportionally allocate the sample among the two (2) chosen categories of elite sprinters and coaches, proportional stratified sampling was used. The researcher divided the whole population into diverse strata namely elite sprinters and coaches and used a formulae recommended by Creswell (2014).

$$\frac{\text{Stratum Population}}{\text{Total Population}} \times \text{Sample}$$

Table 3.1: Proportional stratified sampling by category for quantitative data

CATEGORY	POPULATION	PROPORTION	SAMPLE
Elite sprinters	60	0.85	51
Coaches	10	0.15	09
TOTAL	70	1.00	60

Source: Own compilation

3.5.3.2 Qualitative study

The sample sizes in qualitative and quantitative research differ (Bryman & Bell, 2015). Various scholars have suggested different ways of coming up with the correct sample size for qualitative studies. One of the principles in determining qualitative study sample size (Saunders et al, 2016) is the saturation point. When sufficient information is gathered to finish the study, when it is no longer feasible to get new information, and when further coding is not feasible, data saturation is reached (O'Reilly & Parker, 2012; Saunders et al, 2017). After interviewing 07 interviewees, the researcher reached a point where responses were becoming similar and concluded that the saturation point has been reached.

3.6 DATA COLLECTION PROCEDURES

3.6.1 Pilot Study

3.6.2 Main Study

Data collection instruments are tools for collecting data from respondents and Saunders et al (2016) state that they include questionnaires, interview guides, and observation checklists.

Questionnaires and in-depth interview guides were used in the study.

3.6.2 .1 Questionnaire

Most often, questionnaires collect numerical data (Saunders et al, 2019; Rowley, 2014). UNESCO said that Zimbabwe's literacy rate was 89% in 2014, whilst the World Bank (2015) calculated that adult literacy in Zimbabwe was 86.87%. Since the target sample comprised elite sprinters and coaches, the researcher employed the questionnaire with full confidence that the respondents could read and write. To allow for statistical analysis, the study's questionnaire included closed-end questions.

The researcher designed the questionnaire in such a way as to address the research objectives (*Appendix A*). A 5-point Likert scale with (1) standing for strongly disagree and (5) standing for strongly agree, was used to assess each inquiry on the questionnaire. The researcher personally hand-delivered a total of 60 to respondents at their work and training places. Maximum cooperation from respondents was guaranteed by the fact that the researcher personally distributed and collected the questionnaire.

3.6.2.2 Interview guide

To conduct structured interviews the study utilised an interview guide. In the interview guide (*Appendix B*), the interview questions were in line with the study's goals. A total of seven (07) coaches were interviewed at their workplaces. The researcher took brief notes on the responses of the interviewees during the interviews. The interview guide gave the researcher direction and made sure that all crucial areas were covered.

3.7 DATA ANALYSIS AND PRESENTATION

3.7.1 Quantitative

Regardless of the kind of data gathered, it is always necessary to filter, purify, and arrange the raw data before using it to help in the search for solutions (Cescon and Jiang, 2020). Tables, figures, and charts representing the analyzed data were produced using SPSS. Descriptive and inferential statistics were employed in the study to examine the quantitative data collected.

3.7.2 Qualitative

When analyzing a collection of qualitative data, thematic analysis is an exceptional method to use to find out more about the beliefs, knowledge, experiences, or values of the subjects (Caulfield, 2019). Thematic analysis was employed to analyse data collected from structured interviews.

3. 8 VALIDITY AND RELIABILITY

3. 8.1 Validity

Validity is the extent to which the conclusions truly relate to the subject at hand (Saunders et al., 2016),. Both internal and external validity were examined. To guarantee that the questionnaire accurately investigated the use of motion analysis to enhance elite sprinter performance, the researcher painstakingly built his research technique, including sampling and instrumentation (Saunders et al., 2016). Theory and literature guided the design and administration of the questionnaire.

To establish external validity, the researcher selected a sample that shared characteristics with the populations to which the results would be generalised.

3.8.1.2 Reliability

To guarantee the instruments' reliability the researcher created the questionnaire with ease of understanding for the respondents. The researcher further conducted Cronbach alpha test on the questionnaire and conducted a pilot test. The interview guide was pretested.

3.9 ETHICAL CONSIDERATION

The aim of ethics in a study is to guarantee that no one is harmed by research activities (Cooper & Schindler, 2012). To ensure ethical conduct, the researcher initially secured an introduction letter from the university.

3.9.1 Informed consent

The researcher sought consent from NAAZ which maintains the record of the sprinters. During the collection of data, the researcher asked for consent from the study participants.

3.9.2 Right to privacy

Resnik (2018) asserts that researchers must give study participants information about the safeguards the researchers will use to maintain privacy as well as any instances in which they

may be compelled by law to violate it. Study participants were assured that the information provided shall only be used for the study and that their privacy and anonymity were guaranteed.

3.10 CHAPTER SUMMARY

The chapter described the approach and research techniques used to guarantee the achievement of the goals of the study. The research approach, design, population, sampling methodologies, data collection methods, and procedure for gathering data employed in the study were discussed. The information gleaned from the data to help answer research questions is presented, examined, and discussed in the next chapter.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

Chapter three presented the research methodology that was used to unearth answers to the research questions. This chapter presents the analysis and interpretation of empirical results drawn from the study. Statistical Package for Social Scientists (SPSS) version 21 was used to analyse quantitative data. Charts, tables, graphs, and figures were used to reduce data quantitative data into information easily understood and descriptive and inferential statistics were used in the interpretation of findings. The chapter is summarised at the end.

4.2 RESPONSE RATE

4.2.1 QUANTITATIVE DATA

To allow comparison of sample and response rate of the study to those achieved by other researchers so that an idea of whether the study response rate is lower or greater, it is very important to specify sample size (Saunders et al, 2016). The researcher personally distributed 60 questionnaires. A sum of 56 questionnaires were returned, yielding a response rate of 93 %.

$$\begin{aligned} \text{Response rate} &= \frac{\text{Returned}}{\text{Targeted respondents}} \times 100 \\ &= \frac{56}{60} \times 100 \\ &= 93\% \end{aligned}$$

Table 4.1: Response rate for questionnaires

Questionnaires distributed	Targeted sample	Questionnaires returned	Response rate
60	60	56	93.0 %

Source: - Primary data(2024)

Mailu (2021) states that there is no widely accepted standard for what constitutes an adequate and suitable response rate. However, in the majority of cases, 20% is too little, 80% is in practice a standard, and 50% is the minimal response rate (Fosnacht, 2017). For this study, the response rate of 93.0 % lies above the de facto benchmark acceptable. Considering the aforementioned, the researcher concluded that the response rate was indicative of the whole population. This was made possible by the researcher's direct administration of the questionnaires and the respondents' interest in the study topic.

RELIABILITY OF THE RESEARCH INSTRUMENT

Reliability testing is necessary in order to guarantee consistency of the results when the same research instrument is employed (Saunders & Rojon, 2019). To gauge the reliability of the questionnaire for the study Cronbach alpha test was conducted. The range of Cronbach's alpha reliability coefficient is typically 0 to 1, and the closer it is to 1.0, the more internally consistent the items on the scale are (Bujang, 2018). The Cronbach's alpha reliability coefficient was calculated and the results shown in Table 4.2 below.

Table 4.2: Cronbach's Alpha

Section	Valid Cases (N)	Number of Items	Cronbach's Alpha Coefficient
B	56	10	0.766
C	56	8	0.735
D	56	4	0.718
			0.743

Source: Primary Data 2024

The results in Table 4.2 above indicate that the three constructs had Cronbach's Alpha coefficients above 0.7. An overall instrument reliability was 0.743 which is above the acceptable 0.70. In this regard, as recommended by (Bujang, 2018) the instrument was internally reliable.

4.3 DEMOGRAPHIC DATA

Cresswell and Guetterman (2019) described demographic data as background inquiries that evaluate the traits of people in a sample. Collection of demographic data allows the determination of whether a sample represents the population.

4.4 PRESENTATION AND ANALYSIS OF DATA LINKED TO THE RESEARCH OBJECTIVES

4.4.1 QUANTITATIVE

One-sample t-test with a test value of 2.5, which represents the middle of a 5-point Likert scale was used to analyse the data descriptive statistics. The results are presented and analysed below:

4.5.1 Motion analysis currently being used to enhance the performance of elite sprinters in Harare.

This research objective focused on investigating the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare. Here, the Motion analysis currently being used to enhance the performance of elite sprinters in Harare as measured by 10 questionnaire items in Section B were investigated.

Table 4.7: Motion analysis currently being used to enhance the performance of elite sprinters in Harare

Motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare	Frequency					Descriptive Statistics	
	SD	D	NS	A	SA	MN	STD

High-Speed Cameras are being utilised to capture sprinters' movements enabling analysis of their running biomechanics	Count %	23 41.1	27 48.2	2 3.6	2 3.6	2 3.6	1.80	.942
Numerous camera angles are being employed to record multiple aspects of the sprinter's movement	Count %	31 55.4	18 32.1	5 8.9	1 1.8	1 1.8	1.63	.865
Motion Capture Systems are being utilised to track sprinter movement in three-dimensional space	Count %	36 64.3	16 28.6	2 3.6	1 1.8	1 1.8	1.48	.809
Force Plates are being used to measure ground reaction forces generated by the sprinter	Count %	1 1.8	5 8.9	4 7 1	24 42. 9	22 39. 3	4.09	0.996
Electromyography (EMG) is being utilised to provide insights into muscle activation patterns to understand aspects of sprinting performance	Count %	17 30.4	30 53.6	9 16.1	0 0.0	0 0.0	1.86	.672
Electromyography (EMG) is being utilised to provide insights into muscle coordination to understand aspects of sprinting performance	Count %	29 2.1	13 2.1	14 1.4	0 0.0	0 0.0	1.73	.842
Video Analysis Software is being used to analyse data from high-speed cameras	Count %	2 3.6	3 5.4	2 3.6	29 51.8	20 35.7	4.11	.966
Stride length is one of biomechanical parameters being measured and analysed	Count %	1 1.8	1 1.8	2 3.6	24 42.9	28 50.0	4.38	.799
Stride frequency is one of biomechanical parameters being measured and analysed	Count %	1 1.8	1 1.8	0 0.0	13 23. 2	41 73.2	4.64	.749

Joint angles is one of biomechanical parameters being measured and analysed	Count %	0 0.0	0 0.0	7 12.5	20 35. 7	51 51.8	4.39	.705
Valid N (listwise)	60							

Source: Primary Data 2024

As illustrated by Table 4.6 above, the results indicate that, " motion Capture Systems are being utilised to track sprinter movement in three-dimensional space " has the slightest rating ($M = 1.48 \pm SD = .809$); meaning that respondents refuted this facet. The mean of 1.48 which is far below 2.5 (which is the test value) indicates that respondents highly refuted the posed statement. Statements regarding use of High-Speed Cameras as well as Electromyography (EMG) motion analysis procedures also received lower ratings than the test value as shown by the mean.

These results are in contrast with Chidambaram and Lumintuarso (2018) who found that assert that the performance of sprinters is enhanced through better training that is achieved by breaking down recorded images from High-Speed Cameras which is analysed through biomechanics analysis.

On the other hand, all the other five statements received a mean rating higher than 2.5 (which is the test value) and standard deviation less than 1 as follows "*Force Plates are being used to measure ground reaction forces generated by the sprinter*": $M=4.09 \pm SD = 0.996$; "*Video Analysis Software is being used to analyse data from high-speed cameras*": $M=4.11 \pm SD = .966$; "*Stride length is one of biomechanical parameters being measured and analysed*": $M=4.38 \pm SD = .799$; "*Stride frequency is one of biomechanical parameters being measured and analysed*": $M=4.64 \pm SD = .749$; and "*Joint angles is one of biomechanical parameters being measured and analysed*": $M=4.39 \pm SD = .705$.

These statistics implies that on average respondents were in agreement with the posed statements. " *Stride frequency is one of biomechanical parameters being measured and analysed on Harare elite sprinters*" had the highest frequency of respondents (54) who agreed to the statement. This implies that respondents were positive that to enhance performance on elite sprinters applying motion analysis on stride frequency is of paramount importance.

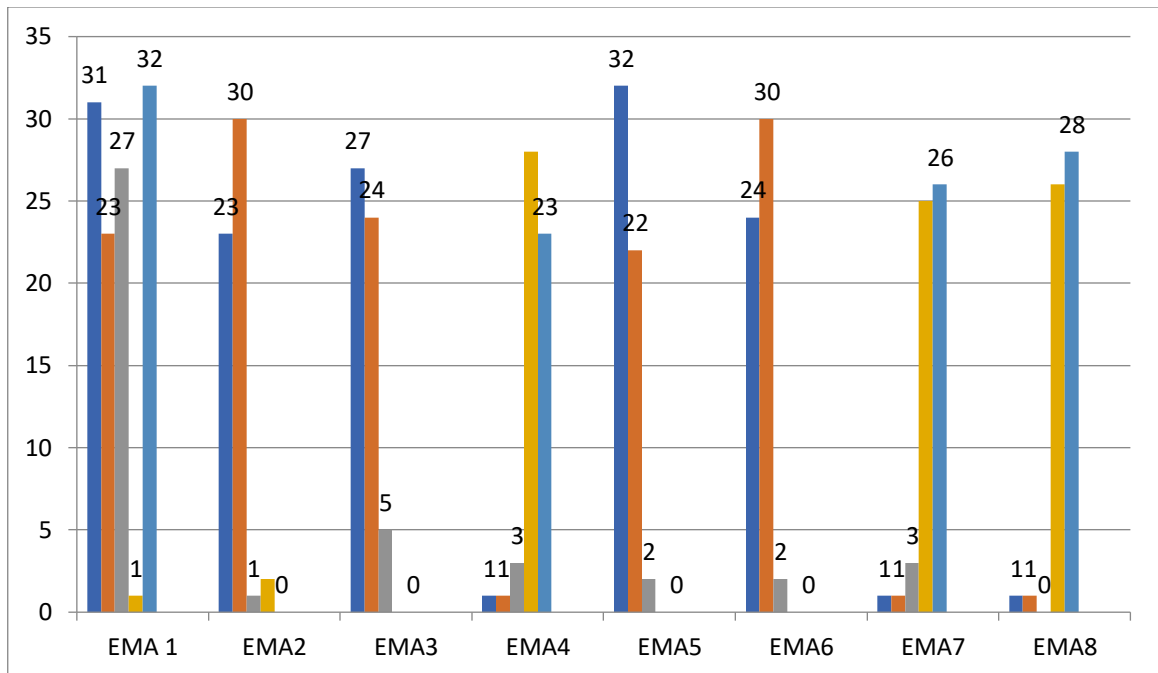
The second research objective was intended at finding the effectiveness of the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare as highlighted by questionnaire items. Table 4.7 below illustrates the distribution of respondents.

Table 4.8: Effectiveness of the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare

	EM A 1	EM A 2	EM A 3	EMA 4	EMA 5	EMA 6	EMA 7	EMA 8
SD	31	23	27	1	32	24	1	1
D	20	30	24	1	22	30	1	1
NS	4	1	5	3	2	2	3	0
A	1	2	0	28	0	0	25	26
SA	0	2	0	23	0	0	26	28
TOTAL	56	56	56	56	56	56	56	56

Source: Primary Data 2024

Figure 4.4: Effectiveness of the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare



Source: Primary Data 2024

Table 4.7 and Figure 4.5 show high frequencies of 31; 23; 27 and 32; 24 on statements 1, 2; 3 and 5; 6 respectively of respondents who strongly disagreed to the posed statements on effectiveness of the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare. There are also high frequencies of 20; 30; 24 and 22; 30 of those who disagreed on the same statements. This shows that respondents were in disagreement on these statements which are 1: "High-Speed Cameras has positively contributed to elite sprinters' performance in Harare"; 2: "Recording multiple aspects of the sprinter's movement through numerous camera angles have positively contributed to elite sprinters"; 3: "Tracking sprinter movement in three-dimensional space through motion capture systems has helped analyse elite sprinter performance" and 5: " Electromyography (EMG) have been key to understanding aspects of sprinting performance through insights into muscle activation patterns"; 6: " Electromyography (EMG) have been key to understanding aspects of sprinting performance through insights".

Respondents were highly positive on statements 4; 7 and 8 where the frequency of those who strongly agreed and agreed totalled: "Force plates have aided performance of elite sprinters through assessing ground reaction forces generated by the sprinter: 51"; "Analysis of data from high-speed cameras has been effective through video analysis software: 51" and "Stride frequency has been one of the positive biomechanical parameters aiding elite sprinter performance: 54" all out of the total frequency of 56. Considering that the constructs were meant to find effectiveness of the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare, statements under 4; 7 and 8 are considered effective.

The findings concur with the study by Janowski, Zielinski, Wlodarczyk, and Kusy (2017) who identified variances on individual highly trained sprinters who utilised force plates in aiding sprinter performance. The findings were further supported by Chidambaram and Lumintuarso (2018) who found that analysing step frequency through motion analysis was important.

4.5.3 Motion analysis procedures that can be adopted to enhance the performance of elite sprinters in Harare

The intent of this research objective was to evaluate the motion analysis procedures that can be adopted to enhance the performance of elite sprinters in Harare. Here the motion analysis procedures as measured by 4 questionnaire items in section D are investigated. Results were run using SPSS and below are the findings.

Table 4.9: Motion analysis procedures that can be adopted to enhance the performance of elite sprinters in Harare

	N	Minimum	Maximum	Mean	Std. Deviation
MAP1: Use of wickets can be one of the procedures that can aid elite sprinter performance in Harare	56	1	5	4.36	.862
MAP2: Slade pull can aid elite sprinter performance in Harare	56	1	5	4.38	.865
MAP3:Speed drills can aid elite sprinter performance in Harare	56	1	5	4.36	.862
MAP4:Running technique elite sprinter performance in Harare	56	1	5	4.32	.855
Valid N (listwise)	56				

Source: Primary Data 2024

Table 4.8 above shows that results from all the four constructs received ratings, the least mean being 4.32 which are way higher than the test value (2,5) showing that on average majority of respondents accepted the proposed motion analysis procedures under this construct. Respondents gave support to the four constructs “use of wickets can be one of the procedures that can aid elite sprinter performance in Harare”; “slade pull can aid elite sprinter performance in Harare”; “speed drills can aid elite sprinter performance in Harare” and “running technique elite sprinter performance in Harare” with mean 4.36; 4.38; 4.36 and 4.32 which shows similar level of support.

4.4.2 QUALITATIVE ANALYSIS

Qualitative data collected through structured interviews with selected coaches of elite sprinters is analysed in this section. Questions from the interview guide were utilised as themes in analysing the data. A total of 07 participants were interviewed. Prior to conducting interviews a set of structured general questions relating to motion analysis were crafted. A thematic analysis was then performed on the data step by step.

4.6.2 Describing findings

4.6.2.1 Can you share your experience and expertise in working with elite sprinters in Harare?

[Participant 1]

"I have worked with elite sprinters for the past ten (10) years. I have coached even at national level".

[Participant 2]

"You mean my experience? I am quite experienced as well as qualified to coach elite sprinters. It has been quite long working with elite sprinters, probably up to 8 years now. I love it and have achieved so much as a coach. Athletes under my club and some who just come for guidance have achieved so much".

[Participant 3]

"It is now some years since embarking on elite sprinters coaching. Soon after retiring from active participation as a sprinter, I embarked on this coaching journey and so far I've seen positive results from my athletes".

[Participant 4]

"I have just joined the coaching field. I am still learning the ropes of elite sprinters though with so much interest".

[Participant 5]

Laughs !!!!!!! "I consider myself a Guru in this area. I have coached several sprinters, including 'You' and you know it. Probably you are better placed to rate me in this field"

[Participant 6]

"My elite sprinters coaching career has been quite hectic. Its aonly that I love it, but I have come across so many challenges. The major one is lack of resources. Imagine going to the field without tools. That's how I can describe it".

[Participant 7]

"There are ups and downs in my experience with the elite sprinters. Of course I have some achievements, but I can quiockly point out one challenge of lack of support to the athletes and coaches both at family and national level".

Responses from the interviewees indicate that they have vast experince and expertise in working with elite sprinters in Harare.

4.6.2.2 What are the current motion analysis procedures you use to assess and improve the performance of elite sprinters?

[Participant 1]:

"Video analysis"

[Participant 3]:

"I personally use wickets. They have produced results for me"

[Participant 5]:

"Wickets are the best".

[Participant 2]:

"I consider running techniques, that is, the coordination of the limbs".

[Participant 4]:

"The physical appearance of the sprinter is what I normally check and work from there".

[Participant 6]:

"Running techniques are what I put first".

[Participant 7]:

"Frequency and leg length is what I consider the major motion analysis procedure".

From the interview question posed, interviewees were in support of such motion analysis procedures as use of wickets and running techniques to be the current motion analysis procedures which they use to assess and improve the performance of elite sprinters

4.6.3 In your opinion, what specific benefits can motion analysis offer in optimizing the performance of elite sprinters?

[Participant 1]:

"The application of proper techniques reduces injuries. Running techniques are improved. It also help to improve running coordination. Weaknesses of an athlete can be identified and corrected among other benefits".

[Participant 4]:

It also help to improve running coordination. It helps identify weaknesses of an athlete thereby taking corrective measures in time".

[Participant 3]:

"It also help to improve running coordination. The application of proper techniques reduces injuries. Weaknesses of an athlete can be identified and corrected among other benefits. Running techniques are improved".

[Participant 6]:

"Weaknesses of an athlete can be identified. Injuries are cut to minimum"

Four out of the seven interview participants gave their opinion as to specific benefits of motion analysis in optimizing the performance of elite sprinters and their responses were very similar. These included minimising injuries, improving running technique and coordination, early identification of athlete weaknesses and improving running coordination".

4.6.4 What motion analysis procedures do you suggest could impact the training and coaching practices for elite sprinters in Harare?

[Participant 2]:

“Use of video analysis during training is one area that I propose must not be overlooked. Also the use of wickets which improves running techniques such as doxflex”.

[Participant 5]:

“I suggest the use of speed ladder that helps maintain frequency of the sprinter”

[Participant 4]:

“I propose using cones for improving stride lengths. My experience and knowledge also taught me that wall drill plays greater role in assisting athletes to use glutes from the starter blocks”.

4.5 CHAPTER SUMMARY

Chapter four presented and analysed data from the study. Moreover, findings of the study were discussed jointly with the existing literature on motion analysis. Descriptive and inferential statistics were utilised in quantitative data analysis whilst thematic analysis was used to analyse qualitative data. Discussion of the findings was guided by the objectives of the study. The next chapter which follows wraps up the research study with the presentation of the summary, conclusions, and recommendations based on the study findings.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

Based on the study findings, this chapter proffer the summary, conclusions, and recommendations. The chapter starts by summarising the key findings of the study, and then draw conclusions from analysis of the findings. Consequently, the recommendations proposed are presented. The chapter goes on to propose areas for further study.

5.2 SUMMARY OF MAJOR FINDINGS

5.2.1 Objective 1: To identify the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare.

The study found that the use of High-Speed Cameras, Motion Capture Systems and Electromyography (EMG) motion analysis procedures was not being implemented by Harare elite sprinters and coaches. It was further found that Force Plates, Video Analysis Software and some Biomechanical Parameters stride length were being measured and analysed on Harare elite sprinters

5.2.2 Objective 2: To evaluate the effectiveness of the motion analysis procedures is currently being used to enhance the performance of elite sprinters in Harare.

It was found from the study that the some of the motion analysis procedures in use such as force plates, analysis of data from high-speed cameras and biomechanical parameters such as stride frequency has been effective in enhancing performance of elite sprinters.

It was further found that even though the use of High-Speed Cameras, Motion Capture Systems and Electromyography (EMG) motion analysis procedures were considered in other studies as being effective, in this study respondents and interviewees could not positively support their

effectiveness which could be attributed to the fact that their use was refuted in objective number one.

5.2.3 Objective 3: To identify the motion analysis procedures that can be adopted to enhance the performance of elite sprinters in Harare.

The study found that all the constructs posed as procedures that can be adopted to enhance the performance of elite sprinters in Harare which are: use of wickets; slade pull; speed drills and running technique were highly supported by the respondents. Similar support eas also found in the responses from the interviews. The findings augers well with the Newton's second law of motion which describes what happens when a net force acts on a body.

5.3 CONCLUSIONS

Based on the empirical findings of the study, the researcher drew the following conclusions.

5.3.1 Motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare.

The study concluded that motion analysis procedures such as force plates, video analysis software and biomechanical parameters such as stride length and frequency are being used to enhance performance of elite sprinters. High-Speed Cameras, Motion Capture Systems and Electromyography (EMG) where however not being used in the effort to enhance performance of elite sprinters in Harare.

5.3.2 Effectiveness of the motion analysis procedures is currently being used to enhance the performance of elite sprinters in Harare

It was concluded that force plates, video analysis software and biomechanical parameters such as stride length and frequency which are the motion analysis procedures in use are effective in enhancing performance of elite sprinters. Further conclusion drawn was that even thogh High-Speed Cameras, Motion Capture Systems and Electromyography (EMG) could be effective, in this study their effectiveness was not revealed as it was found that they were not being used in the effort to enhance performance of elite sprinters in Harare

5.3.3 Motion analysis procedures that can be adopted to enhance the performance of elite sprinters in Harare.

Conclusions were drawn that use of wickets, slade pull, speed drills and running techniques were the proposed motion analysis procedures to enhance the performance of elite sprinters in Harare.

5.4 LIMITATION OF THE STUDY

Much of the literature sources which provided a theoretical framework for the study were not written from a Zimbabwean perspective, therefore they may fail to accurately address motion analysis in the Zimbabwe context considering economic, and technological conditions. The study however also employed literature from few studies conducted locally.

On the methodology used, the study adopted a concurrent mixed method which despite its strength, concurrent collection of quantitative and qualitative data could not allow to address challenges of findings of one method with another. Time permitting the study would have employed one data collection method after the other.

To alleviate this limitation, the study tailor made both quantitative and qualitative data collection instruments to address this challenge.

5. 5MPLICATIONS/RECOMMENDATIONS

5.5.1 Implications for practice

The study recommends that motion analysis procedures be fully utilized to aid performance of elite sprinters.

Such motion procedures as procedures High-Speed Cameras to capture sprinters' movements at three dimensional angles, to record multiple aspects, use of Electromyography (EMG) and biomechanical parameters of joint angles should be fully employed to improve performance of elite.

5.5.2 Implications for Theory

The study aid to literature on motion analysis from a locally point of view.

5.5.3 Implications for Future Research

Future studies can be focused on conducting research to validate the conceptual framework that was proposed in this study. This will help bridge the gaps that were identified to exist in motion analysis literature.

The study has highlighted the use of motion analysis to enhance elite sprinter performance in Harare, and opens up possibility of undertaking further research on motion analysis in other sporting disciplines.

5.6 CHAPTER SUMMARY

Chapter five laid bare summary of major findings, conclusions, limitations of the study, implications and recommendations and end with a summary.

REFERENCES

Banda, M. (2015) Anthropometric Profile, Physical Fitness and Cognitive Functioning of Elite Zimbabwean Football Referees, Thesis, MSc (Sport Science), Department of Sport Science, Faculty of Education, Stellenbosch University: Supervisor: Dr H.W. Grobbelaar, Co-Supervisor: Prof E. Terblanche

Berg, V. (2015) Global positioning system tracking and kinanthropometrical profiling of Zimbabwean National Rugby Sevens players, PHD Thesis , North West University Supervisor: Prof DDJ Malan

Bujang, M. A. ; Omar, E. D. and Baharum, N. A. (2018) A review on sample size determination for Cronbach's Alpha Test: A simple guide for researchers, 25(6): DOI10.21315/mjms2018.25.6.9 at <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6422571/>

Chadamabaram, V. and Lumintuarso, R. (2018) Steps dynamics analysis in 100 m sprint biomechanics study in elite and junior sprinters, 2nd international conference on Sports Sciences and Health, v7

Chingoma , G. (2021) Athletics coaches back in class, The Herald, 22 October 2021 at <https://www.herald.co.zw/athletics-coaches-back-in-class/>

Fasih, M. and Zia, A. (2020) Kinematical analysis of hundred metres(100m) sprinters of Elite and Sub Elite Level in Pakistan, European journal of sports & Exercise Science, 8(3) at <http://scholarresearchlibrary/achive.html>.

Fosnacht, K.; Sarraf, S.; Howe, E. and Peck, L.K. (2017) How important are high response rates for College surveys?, The Review of Higher Education, 40(2) at <https://doi.org/10.1353/rhe.2017.0003>

Gill, J. and Johnson, P. (2017), Research Methods for Managers, Third Edition, Sage Publications Ltd, London.

Haugen, T., Seiler, S., Sandbakk, Ø. *et al.* The Training and Development of Elite Sprint Performance: an Integration of Scientific and Best Practice Literature. *Sports Med - Open* 5, 44 (2019). <https://doi.org/10.1186/s40798-019-0221-0>

IAAF World Indoor Championships (2018) Biomechanical Report for the 60 Metres Men. Birmingham, UK: International Association of Athletics Federations.

International Olympic Committee (2024) Olympic Marketing Fact File 2024 Edition at <https://stillmed.olympics.com/media/Documents/International-Olympic-Committee/IOC-Marketing-And-Broadcasting/IOC-Marketing-Fact-File.pdf>

Johnston, R.J., Watsford, M.L., Pine, M.J. & Sporri, D. 2013. Assessment of 5 Hz and 10 Hz GPS units for measuring athlete movement demands. *International journal of performance analysis in sport*, 13(1):262-274

Jonowski, M.; Zielinski, J.; Wlodarczyk, M. and Kusy, K. (2017) Kinematic analysis of the block start and 20-metere acceleration phase in two highly-trained sprinters: A case report, *Baltic Journal of Health and Physical Activity* 2017; 9(3)

Korhonen MT, Suominen H, Viitasalo JT, Liikavainio T, Alen M, Mero AA. Variability and symmetry of force platform variables in maximum-speed running in young and older athletes. *J Appl Biomech.* 2010;26(3):357–366.

Koule, M.N. (2017), Qualitative Research Methods for Social Science, Pearson Education, Boston.

Leedy, P.D (2019) Practical Research: Planning and Design 3rd Edition, Prentice Hall, New Jersey.

Leedy, P.D (2019) Practical Research: Planning and Design 8th Edition, Prentice Hall, New Jersey.

Machado, N. and Carvalho, P., S. (2020) Newton's Laws of Motion: Analysis of a complete virtual experiment with interactive material, Conference Paper, DOI:10.21125/edulearn.2020.1892 at <https://www.researchgate.net/publication/343419054>

Morin, J.; Edouard, P. and Samozino, P.(2013) New insights into sprint biomechanics and determinants of elite 100m performance, *New Studies in Athletics* · no. 3./4.2013

Moir, G. (2015) biomechanics of fundamental movements: Sprint running, at <https://www.researchgate.net/publicatio/286779787>

Pappas P, Paradisis G, Vagenas G. Leg and vertical stiffness asymmetry between dominant and non-dominant legs in young male runners. *Hum Mov Sci.* 2015;40:273–283.

Qui, Y.; Guan, Y. and Liu, S. (2023) The analysis of infrared high-speed motion capture system on motion aesthetics of aerobics athletes under biomechanics analysis, 18(5), DOI: 10.1371/journal.pone.0286313

SafeAbroad Forecast Report (2024) The 2024 Paris Summer Olympics and Paralympics, Safety implications for international education programs at https://safeabroad.com/wp-content/uploads/2024/04/Forecast-Report_-The-2024-Paris-Summer-Olympics-and-Paralympics.pdf

Smith, G. (2007) Newton's Philosophiae Naturalis Principia Mathematica at <https://plato.stanford.edu/entries/newton-principia/>

Trivers R, Fink B, Russell M, McCarty K, James B, Palestis BG. (2014) Lower body symmetry and running performance in elite Jamaican track and field athletes. *PLoS ONE.* 2014;9(11):e113106.

Tai, W.; Zhang, R and Zhao, L. (2023) Cutting-edge research research in sports biomechanics: From basic science to applied technology, 10(6), DOI:10.3390/bioengineering10060668

Vuong, J.,; Edel, A.; Vob, P. and Ferrauti, A. (2022) Effectiveness and kinematic analysis of initial step patterns for multidirectional acceleration in team and racquet sports, Journal of Human Kinetics, 85/22: DOI:10.2478/hukin-2022-0106



Appendix A: Questionnaire for Elite coaches and sprinters

Dear respondent

My name is Kamungeremu Dicksson, a Bachelor of Science Honours in Sports Science and Management Degree student at Bindura University of Science Education. I am conducting a research on Using motion analysis to enhance the performance of elite sprinters in Harare. Please note this research is purely for academic purposes and shall not be used for any other purpose without the consent of the participants. The information gathered will be treated as highly confidential always. I appreciate your willingness to help me in my research effort.

GENERAL INSTRUCTIONS

Kindly attempt all questions. *(please tick where appropriate)*

SECTION A: DEMOGRAPHIC INFORMATION

1. Age

18 to 25 years

26 to 33 years

34 years and above

2. Gender

Male

Female

3. Level of education

Primary	<input type="checkbox"/>
Secondary	<input type="checkbox"/>
Certificate	<input type="checkbox"/>
Diploma	<input type="checkbox"/>
Degree	<input type="checkbox"/>
4. 5	
0-5 Years	<input type="checkbox"/>
6-10 years	<input type="checkbox"/>
11-15 years	<input type="checkbox"/>
16 years and above	<input type="checkbox"/>

SECTION B: Motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare.

Please assess the relevance of the following motion analysis currently being used to enhance the performance of elite sprinters in Harare. Indicate your response against each of the following statements on a scale of 1-5 as highlighted below: 1= Strongly disagree; 2= Disagree; 3= Not Sure; 4= Agree ; 5=Strongly agree.

Statement	1	2	3	4	5
MA1: High-Speed Cameras are being utilised to capture sprinters' movements enabling analysis of their running biomechanics					
MA2: Numerous camera angles are being employed to record multiple aspects of the sprinter's movement					
MA3: Motion Capture Systems are being utilised to track sprinter movement in three-dimensional space					
MA4: Force Plates are being used to measure ground reaction forces generated by the sprinter					
MA5: Electromyography (EMG) is being utilised to provide insights into muscle activation patterns to understand aspects of sprinting performance.					

MA6: Electromyography (EMG) is being utilised to provide insights into muscle coordination to understand aspects of sprinting performance					
MA7: Video Analysis Software is being used to analyse data from high-speed cameras					
MA8: Stride length is one of biomechanical parameters being measured and analysed on elite sprinters in Harare					
MA9: Stride frequency is one of biomechanical parameters being measured and analysed on elite sprinters in Harare					
MA10: Joint angles is one of biomechanical parameters being measured and analysed on elite sprinters in Harare					

SECTION C: Effectiveness of the motion analysis procedures currently being used to enhance the performance of elite sprinters in Harare

Please assess the relevance of the following statements relating to effectiveness of the motion analysis procedures is currently being used to enhance the performance of elite sprinters in Zimbabwe. Indicate your response against each of the following statements on a scale of 1-5 as highlighted below: *1= Strongly disagree; 2= Disagree; 3= Not Sure; 4= Agree; 5=Strongly agree*

Statement	1	2	3	4	5
EMA1: High-Speed Cameras has positively contributed to elite sprinters' performance in Harare					
EMA2: Recording multiple aspects of the sprinter's movement through numerous camera angles have positively contributed to elite sprinters					
EMA3: Tracking sprinter movement in three-dimensional space through motion capture systems has helped analyse elite sprinter performance					

EMA4: Force plates have aided performance of elite sprinters through assessing ground reaction forces generated by the sprinter					
EMA5: Electromyography (EMG) have been key to understanding aspects of sprinting performance through insights into muscle activation patterns.					
EMA6: Electromyography (EMG) have been key to understanding aspects of sprinting performance through insights into muscle coordination.					
EMA7: Analysis of data from high-speed cameras has been effective through video analysis software					
EMA8: Stride frequency has been one of the positive biomechanical parameters aiding elite sprinter performance					

SECTION D: Motion analysis procedures that can be adopted to enhance the performance of elite sprinters in Zimbabwe

Please assess the relevance of the following statements relating to strategies to motion analysis procedures that can be adopted to enhance the performance of elite sprinters in Zimbabwe. Indicate your response against each on a scale of 1-5 as highlighted below: *1= Strongly disagree; 2= Disagree; 3= Not Sure; 4= Agree ; 5=Strongly agree*

Statement	1	2	3	4	5
MAP1: Use of wickets can be one of the procedures that can aid elite sprinter performance in Harare					
MAP2: Slade pull can aid elite sprinter performance in Harare					
MAP3:Speed drills can aid elite sprinter performance in Harare					
MAP4:Running technique elite sprinter performance in Harare					

Thank you for answering the questionnaire.



**Appendix B: Interview guide used to guide discussions with coaches
of elite sprinters in Harare**

1. Can you share your experience and expertise in working with elite sprinters in Harare?
2. What are the current motion analysis procedures you use to assess and improve the performance of elite sprinters?
3. In your opinion, what specific benefits can motion analysis offer in optimizing the performance of elite sprinters?
4. What motion analysis procedures do you suggest could impact the training and coaching practices for elite sprinters in Harare?